

# **Retrograde Part Identification Using 2<sup>nd</sup> Generation Marking and Reading Techniques**

**(Parts ID project)**

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**Emerging Project Development**

# Machine readable code



**Bar  
Codes**



**Data  
Matrix™**

TM of RVSI

# Participants

## ■ Government

- CTMA (**Project Leader**)
  - Department of Defense
  - Department of Transportation
  - Federal Aviation Administration
  - NASA
  - National Transportation Safety Board
  - United States Army
  - United States Air Force
  - United States Coast Guard
  - United States Marine Corps
  - United States Navy
- ## ■ University
- University of Tennessee, Space Institute

## ■ Industry

- RVSI (Industry Lead)
- Ferro
- FOBA Laser Systems
- Monode Marking Products, Inc.
- Optomec
- Pannier Corporation
- Telesis
- 3-D Systems
- BF Goodrich
- Honeywell
- Solar Turbines
- Boeing Defense
- Cummins Engine
- Howmet



# Fact finding sites

- US Air Force Materiel Command, Hill Air Force Base, UT
- US Army Anniston Depot, AL
- US Army Corpus Christi Army Depot, TX
- US Coast Guard Aircraft Repair & Supply Center, Elizabeth City, NC
- US Marine Corp Air Station, Cherry Point, NC



# Major problems identified

- Part identifiers are routinely damaged and rendered unreadable after being subjected to harsh operational and overhaul processes.
- Products and procedures are needed to restore marking contrast in the field.
- Marking systems are not available for field marking (post delivery hardware).
- Readers are needed to locate, image, and decode markings covered over with protective coatings and/or paints.
- 2-D technology is not adequately addressed by industry and military standards.

# Government customers affected

- Defense Logistics Agency
- Defense of Defense
- Department of Transportation
- Federal Aviation Administration
- National Aeronautics & Space Administration
- National Transportation Safety Board
- United States Army
- United States Air Force
- United States Coast Guard
- United States Marine Corps
- United States Navy



# Conditions causing part identification damage

- Abrasion/impact damage, e.g., foreign object strikes, sand blasting, shot peening, etc.
- Corrosion/oxidation, e.g., parts exposed to salt fog, spray, splash, etc.
- Contamination, e.g., dirt build-up, burnt oil, fluid staining, etc.
- Color change caused by heat or UV exposure
- Material removal during paint stripping and surface cleaning operations
- Coatings applied over markings during plating and painting operations

# Project focus established



# Project focus areas

- Identify marking processes that will survive harsh environments:
  - Intrusive marking processes
  - Additive marking processes
- Symbol contrast restoration
- Evaluate read-through-paint readers
- Marking methods for sand casting, forging and investment casting
- Equipment portability

## Project focus was not

- Evaluation and comparison of machine-readable symbols
- Evaluation and comparison of optical reader/decoders

# USAF Marking Focus (Hill AFB Depot)

## FIGHTERS, BOMBERS & CARGO AIRCRAFT

Marking effort will focus on:

Uninstalled landing gear components

- Struts
- Wheels
- Brakes



# USN/USMC Marking Focus (Cherry Point Depot)

## HELICOPTERS AND FIXED WING AIRCRAFT

Marking effort will focus on:

### Engine and APU components

- Turbine Blades
- Disks
- Shafts
- Compressor parts
- Combustor components
- Housings



# US Army Marking Focus (Anniston Depot)

## M1, MIA1, M1A2 Tanks & small arms

Marking effort will focus on:

### Uninstalled components

- Selected tanks components
- M16A1/2 Rifles and M9 Pistols



# US Army Marking Focus (Anniston Depot)



Marking Location for M16, 5.56MM Rifle



Marking Location for M9, 9mm pistol



# Marking Tasks (Harsh Environments)

- **Task 1** - Identify part whose identifiers are damaged during harsh operational and overhaul processes.

Part Information Needed to Support Marking Tests (To be supplied by customers)

- Part Number
- Nomenclature
- Material Type Including Coatings
- Surface Roughness
- Gray Scale Color (As Defined by Grayscale Comparator)
- Available Marking Area (Dimensions)
- Current Marking Method

**Responsible Organizations:** BF Goodrich, Solar Turbine, Honeywell, Boeing, Howmet, US Army, USAF, USMC & USN



# Marking Tasks (Harsh Environments)

- **Task 2** - Identify conditions causing part Identification damage

**Resp. Organizations:** Honeywell, Solar Turbine, US Army, USAF, USMC & USN

- **Task 3** – Supply material test coupons and/or actual parts for marking and evaluation

**Resp. Organizations:** BF Goodrich, Foba Laser/Cummins, Solar Turbine, US Army, USMC, USN, USAF & 3-D Systems/Howmet, Ferro, UTSI, RVSI

- **Task 4** - Develop marking processes for items identified in task 1 that will survive conditions identified in Task 2

**Resp. Organizations:** RVSI



# Marking Tasks (Harsh Environments)

## Direct Part Marking (DPM) Processes to be Evaluated

- New Cast, Forge, and Mold Processes
- Dot Peen (deeper marking)
- Laser Engineered Net Shaping
- New Deep Laser Engraving Process
- Laser Induced Surface Improvement (different materials)
- Micro-milling
- Stencil - Thermal Spray (HVOF, Arc, and Flame Spray)

# Marking Tasks (Harsh Environments)

- **Task 5** - Apply markings to parts and materials (test coupons)

**Resp. Organizations:** Cummings, Foba, Howmet, NASA, RVSI, Telesis, 3D Systems, Ferro

- **Task 6** - Conduct tests to determine marking effects on substrate materials (new marking processes not approved by government standard)  
Testing requirements will be coordinated with the customer and will typically include one or more of the following (next slide):



# Marking Tasks (Harsh Environments)

- Metallurgical Testing
- Corrosion Testing
- Fatigue Testing
- Temperature (hot, cold and hot & cold cycles)
- Abrasion Resistance
- UV Exposure
- Impact Resistance
- Chemical Resistance

Resp. Organizations: University of Tennessee Space Institute  
and USAF as required

# Marking Tasks (Portable Markers)

- **Task 7** - Expose approved marking processes to simulated or actual operational environments (ground test) and overhaul

**Resp. Organizations:** Solar Turbine, Honeywell, BF Goodrich, USAF

Note: Flight testing is outside the scope of this project and will be conducted by USCG

- **Task 8** - Based on conditions witnessed during fact finding, design and manufacture prototype portable marking carts.

**Resp. Organizations:** Monode, Pannier Corporation, RVSI, UTSI



# Marking Tasks (Portable Markers)

- **Task 9** - Conduct marking tests under simulated conditions and fine tune design/prototype as required. Deliver Units to DoD

**Resp. Organizations:** Monode and Pannier Corporation

- **Task 10** - Conduct on-site marking device evaluations

**Resp. Organization:** USAF

# Marking tasks

- Portable Marking Carts
  - Additive marking process carts
    - Decals, stencil, ink jet, laser bonding, coat and laser
  - Subtractive marking process carts
    - Small parts
      - Laser, electro chem-etch, micro-machining, deep marking pin stamp
    - Large parts
      - Remote laser marking head
- Casting and forging marks

# Portable Marking Device Requirements

- Markers must be capable of applying 2-D markings to selected parts in the field, both installed and uninstalled
- Must be capable of applying markings in accordance with the provisions of NASA-STD-6002 and NASA-HDK-6003 and/or other selected military specification(s)
- Must be computer driven
- Must contain user friendly software containing provisions for storing marking instructions and settings by part number and/or material type
- Must include mark quality verification capability

# Direct Part Marking (DPM) Processes to be Evaluated

## Field use (make portable)

- Dot Peen
- Electro Chemical Coloring
- Laser Bonding
- Laser Etching
- Ink Jet
- Stencil (Paint & Ink)

# Portable Marking Enhancement Kit

- **Task 11** - Design, manufacture and test a portable marking enhancement kit and deliver to evaluating sites.

Contains shall include but not be limited to:

- Cleaning cloths
- DoD approved surface cleaning agents
- Surface scuffing materials, e.g., scotchbrite pads
- Electrolysis type cleaning system to remove oxidation layers
- Light and dark colored backfill media
- Protective clear coats (MIL-HDBK-132)
- Corrosion inhibitors
- Instructions to outline the process and requirements for removing contaminants, oxide films, heat induced discoloration, corrosion products and foreign contamination from metallic and non-metal surfaces

**Resp. Organization:** Monode



# Portable Marking Enhancement Kit

- **Task 12** - Conduct marking device and enhancement kit training at evaluation sites.

**Resp. Organizations:** Monode, RVSI and Pannier Corporation

# Reading Tasks

- **Task 13** - Deliver Optical and RTP readers to required customer sites
  - Ultra-Sound
  - Magneto-Optic

**Resp. Organization:** RVSI, Imperium, PRI

- **Task 14** - Conduct reader training at evaluation sites

**Resp. Organization:** RVSI

- **Task 15** - Conduct reading tests as marked parts are processed through operational and overhaul processes. Coordinate problems with RVSI

**Resp. Organizations:** Solar Turbine, Honeywell, BF Goodrich, RVSI, US Army, USN, USMC & USAF



# Reading Device Requirements

- Must be capable of reading marked components in the field, both installed and uninstalled without significant manual intervention, i.e., cleaning, backfilling to restore contrast, etc.
- Must be fully portable and capable of a minimum of 1000 reads between battery charge.
- Must be capable of reading markings made in accordance with NASA-STD-6002, NASA-HDBK-6003, AS9132 and/or other selected military specification(s)
- Must be easily configured to adapt to changing light conditions
- Must interface with open architectures
- Must be able to read the mark after depot processing



# Standard Tasks

- **Task 16** – Submit Information required to update Marking Standards and Handbooks as required.

**Resp. Organizations:** RVSI and the following organizations:

- DoD LOG AIT Office
- USAF
- NASA
- ISO
- Delta Airlines
- IAQG



# Deliverables

- Marked parts and/or material samples
- Material test report(s)
- Post run/overhaul reading reports
- Portable markers including reader and mark quality verification software
- Portable marking contrast enhancement kits
- Read-through-paint (RTP) readers
- Training (including technical instructions) necessary to ensure that at least two artisans can safely operate and maintain the portable marking devices, optical readers, and RTP readers at each military evaluation center
- Final program report

# Estimated Duration

Task	1 <sup>st</sup> Qtr	2 <sup>nd</sup> Qtr	3 <sup>rd</sup> Qtr	4 <sup>th</sup> Qtr	5 <sup>th</sup> Qtr
Submit concept paper to NCMS	*				
Approve Project	*				
OK to proceed	*				
Perform Marking Tasks	→				
Perform Reading Tasks			→		
Update for Standards					→
Write final report				→	
Project completed					*

# Estimated Costs

Total project cost: \$4.7 M

CTMA funds: \$1.4 M

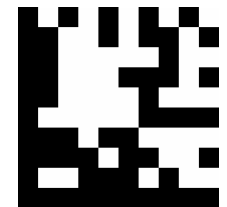
\$2.35 from industry for each \$1 from DOD



# Benefits - Common Purpose

Develop a Means to Safely Apply Machine-Readable Markings (2-D Symbols) to Military Equipment to Facilitate Automatic Tracking

- Reduce data errors and speed data input
- Achieve total asset visibility
- Reduce use of counterfeit/unauthorized parts
- Improvements in material reliability determinations
- Remove/lessen paperwork
- *Improve Safety*



# Questions & Answers

